THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI, TAMILNADU

MANAGEMENT OF IPSILATERAL FRACTURES OF SHAFT OF FEMUR AND BOTH BONES LEG THROUGH A SINGLE PERCUTANEOUS INCISION

DISSERTATION SUBMITTED FOR

MS DEGREE (BRANCH II - ORTHOPAEDIC SURGERY)

MARCH 2008

DEPARTMENT OF ORTHOPAEDICS
MADURAI MEDICAL COLLEGE AND
GOVERNMENT RAJAJI HOSPITAL
MADURAI.

CERTIFICATE

This is to certify that the dissertation entitled ***"MANAGEMENT OF IPSILATERAL FRACTURES OF SHAFT OF FEMUR AND BOTH BONES LEG THROUGH A SINGLE PERCUTANEOUS INCISION"*** is a bonafide record of work done by ***Dr. M. MOHAMMED YOUNUS*** in the Department of Orthopaedics, Government Rajaji Hospital, Madurai Medical College, Madurai, under the direct guidance of me.

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DECLARATION

I, **Dr. M. MOHAMMED YOUNUS,** solemnly declare that the dissertation entitled "***MANAGEMENT OF IPSILATERAL FRACTURES OF SHAFT OF FEMUR AND BOTH BONES LEG THROUGH A SINGLE PERCUTANEOUS INCISION"*** has been prepared by me under the able guidance and supervision of my guide **Prof. M. Chidambaram, M.S.ORTHO., D. ORTHO., Prof & HOD,** Department of Orthopaedics and Traumatology, Madurai Medical College, Madurai, in partial fulfillment of the regulation for the award of **M.S. (ORTHOPAEDICS)** degree examination of The Tamilnadu Dr. M.G.R. Medical University, Chennai to be held in March 2008.

This work has not formed the basis for the award of any other degree or diploma to me previously from any other university.

Place : Madurai

Date :

ACKNOWLEDGEMENT

I am deeply indebted to my beloved chief and my teacher, Prof. Dr. **M. Chidambaram, M.S.Ortho, D.Ortho., Professor and Head of the Department of Orthopaedics, Madurai Medical College,** Madurai for the able guidance, inspiration and encouragement he has rendered at every stage of this study.

I am grateful to my beloved teachers **Prof. Dr. A. Rajamani, Prof. Dr. Malairaju, Prof. P.V. Pughalenthi, Dr. T. Chandraprakasm** for their invaluable help and guidance rendered to me in preparing this dissertation.

I express my heartfelt gratitude to **Dr. V. Ramar, Dr. S. Shanmuganathan, Dr. Ravichandran, Dr. V.R. Ganeshan, Dr. Arivasan, Dr. R. Sivakumar,** Assistant Professors of Orthopaedics, Madurai Medical College, Madurai for their valuable advice and help in carrying out this study.

I sincerely acknowledge with gratitude the guidance and persistent encouragement given to me by **Dr. Ramanathan, Dr. M.N. Karthi, Dr. Thanappan, Dr. Thirumalai Murugan, Dr. K.P. Saravana Kumar, Dr. Suresh Kumar** and all our assistant professors.

My sincere thanks to **Dean, Madurai Medical College,** Madurai for permitting me to utilize the clinical materials of the hospital.

I would like to thank my patients, friends and colleagues & family who have stood by me throughout this work and above all the **GOD FOR HIS KINDNESS THROUGHOUT THIS STUDY**.

CONTENTS

INTRODUCTION

Ipsilateral fractures and shaft of femur and both bones leg is an unique combination of injuries. It was described by the term “floating knee” by Blake and McBryde way back in 1974.

This usually results from high energy trauma particularly motor vehicle accidents. It is frequently associated with other life threatening injuries in as high as 74% of patients. It is also associated with significant mortality rates (5-15%).

In about 59-67% of cases either one or both fracture were found to be compound. There is a need for amputation in about 20-30% of cases because of associated neurovascular injury.

In these patients once the initial concern of preservation of life is fulfilled, focus should change towards early management and rehabilitation of the patient.

This is most commonly achieved via intramedullary nailing of the femur and either external fixation or intramedullary nailing of the tibia.

AIM

The purpose of this study is to analyze the efficacy of management of ipsilateral fractures of shaft of femur and both bones leg using retrograde femoral interlocking nailing and antegrade tibial interlocking nailing through a single percutaneous incision.

SURGICAL ANATOMY OF FEMUR

The femur or thigh bone is the longest and strongest bone in the body. Its shaft is almost cylindrical in most of its length and bowed with forward convexity. Its upper extremity has a rounded articular head, projecting medially on short neck of bone formed by the medial inclination of the upper part of the shaft. The distal or inferior extremity is more massive being in the form of double knuckle or condyle articulating with tibia.

The upper end of the femur comprises a head, neck, a greater and a lesser trochanter. The head of the femur is more than half sphere. It is directed upwards, medially and slightly forwards to articulate with the acetabulum. It has an anteversion of 15°.

The neck of femur which is about 5cm long connects the head and shaft which it forms an angle between 125° to 135°. The anterior surface of the neck in flattened and at its junction with the shaft is marked by a prominent rough ridge termed intertrochanteric line. The posterior surface of the neck at its junction with the shaft is termed as intertrochanteric crest.

The greater trochanter in a large quandralangular portion at the upper part of the junction of neck with shaft. It provides insertion for most of the muscles of gluteal region.

The apex of the trochanter overlies trochanteric fossa. This fossa lies along the longitudinal axis of the shaft of femur. Many vascular foramina directed towards the head of femur penetrate the upper and anterior surface of neck of femur.

The lesser trochanter is a conical eminence which projects medially and backwards from the shaft at its junction with the lower and posterior part of neck. It has psoas major attached on its head. The shaft of femur is narrowest in its middle. It expands a little, as it is traced upwards. But it wider appreciably near the lower end of bone.

Anterior Bowing:

The most prominent feature of the femur is the anterior bowing. Wide individual variations exist in the magnitude the bow.

In its middle third the shaft possesses three surfaces and three borders. The anterior surface in smooth and gently convex in all directions. The lateral surface in directed more backwards than laterally. The posterior border is formed by a broad ridge, termed a linea aspera which usually forms a crest like projection with distinct lateral and medial lips.

In this situation the compact bone of the shaft is increased in amount to withstand the compression forces concentrated here by its anterior curvature. The medial surface in directed medially and slightly backwards.

The medullary canal of femur:

The shaft of femur is a cylinder of compact bone with a large medullary cavity. The wall of the cylinder is thick in the middle third of the shaft, above and below the wall becomes thinner. Thus the narrowest region of the medullary canal in located immediately proximal to the middle. In the isthmus region the cortex has its greatest thickness; proximally the cavity becomes slightly larger towards the lesser trochanter. After that, it widens rapidly and filled with dense network of trabeculae. Distal from the middle the canal widens gradually towards the distal diaphysis.

SURGICAL ANATOMY OF TIBIA

The tibia, with its asymmetric surrounding soft tissues, determines the shape of the lower part of the leg. Its roughly triangular external cross section has an anteriorly directed apex. Its anteromedial subcutaneous surface has no muscular or ligamentous attachments from the level of pes anserinus tendons and tibial collateral ligament of the knee to the deltoid ligament of the ankle.

Open fractures occur more often in the tibia because of the general lack of soft tissue coverage, making contamination a common concern in tibial intramedullary nailing. Furthermore, displacement of open tibial fracture fragments leads to periosteal stripping of the anterior tibial surface, rendering this exposed cortical bone avascular. Soft tissue closure or coverage of the fracture, which is rarely a problem in the thigh, is a major concern in the leg.

The proximal tibial metaphysis, with its medial and lateral tibial plateaus, is much larger in diameter than the shaft but is similarly triangular in cross section. Its anterior apex forms the tibial tubercle with the attached patellar ligament. Also apparent is the apex-anterior angulation of the proximal end of the tibia, which averages 50°. The backward-sloping, but variably shaped anterior surface of the tibial metaphysis offers a more or less obvious surface for inserting an intramedullary nail. The cancellous bone of the proximal metaphysis can be perforated fairly easily to gain access to the medullary canal. However, the shape of the proximal end of the tibia, its posterior overhang, and its thin, flat posterior wall make it possible to err and perforate the posterior cortex.

Distally, the shaft flares and becomes more rounded as it undergoes a transition from diaphysis to metaphysis. The cortex thins, and the fatty medullary contents are replaced with cancellous bone that is surprisingly dense. This cancellous bone provides secure purchase for screws and is often compact enough to resist penetration by an intramedullary nail.

The contour of the distal end of the tibia is notable for a somewhat pronounced concavity on its anteromedial surface. Restoring this distal medial concavity is an essential part of closed reduction of distal tibial shaft fractures.

Medullary canal of Tibia

The medullary canal of tibia extends from the cancellous bone of the proximal metaphysis to that of the distal metaphysis. If the canal were extended proximally along its axis, it would enter the lateral plateau because of the relatively greater medial overhang. The largest sagittal dimension of the proximal end of the tibia is also laterally located. Buehler and associates pointed out that for both these reasons, a lateral entry site for an intramedullary nail, anterior to the lateral intercondylar eminence, is least likely to deform a proximal fracture. The diaphyseal canal is significantly more round in cross section than the external appearance of the tibia would suggest. Unlike the femur, it is more hour-glass shaped than tubular, with a variably pronounced isthmus. Even after intramedullary reaming, a snug fit for an intramedullary nail can be obtained only in the middle few centimeters of the tibia. This limitation adversely affects the stability of proximal and distal fractures fixed with a nail. In the young, the medullary canal tends to be narrow. With aging and osteoporosis, the cortex becomes thinner, the metaphyseal cancellous bone becomes less dense, and the internal diameter of the medullary canal increases.

A thick interosseous membrane connects the lateral crest of the tibia to the anteromedial border of the fibula. Its major fibers run downward and laterally. This membrane is often largely intact after indirect torsional fractures of the tibia, and according to Sarmiento, Latta, and others, it is the major constraint to shortening of such injuries.

The tibia and fibula are surrounded by soft tissues that are most important in any consideration of injuries to this region In fact, surgeons who pay more attention to the bones than to these soft tissues may commit irretrievable errors in evaluating and treating fractures of the tibia and fibula. The soft tissue envelope of the leg is injured to a greater or lesser extent whenever a fracture occurs. Open wounds are usually obvious, although they may be small and may under-represent the extent of damage within.

MECHANISM OF INJURY

This combination of injuries usually results from high velocity injury, particularly motor vehicle accidents. Numerous associated injuries occur in conjunction with this injury pattern and they include fractures of the femoral neck, intertrochanteric region, patella, acetabulum and pelvis. Soft tissue trauma to the knee also commonly occurs and requires careful physical examination and further radiological studies.

Associated abdominal, thoracic and / or head injuries require evaluation by a well equipped trauma team and appropriate resuscitation and surgical management.

RADIOLOGICAL EXAMINATION

Plain X-rays are the initial step in evaluation and often are the only investigation required for diagnostic confirmation. Plain x rays of the full length of femur and leg in two planes (AP and lateral) should always be combined with a x-ray AP view of pelvis so as not to miss an occult fracture of the femoral neck.

Classification

We used both AO system of classification and Winquist and Hansen's classification of fracture comminution in our series.

AO system of classification of fractures of femur Diaphysis

32 A=Simple fracture

32 A1 Simple fracture, spiral

32 A2 Simple fracture, oblique (≥30°)

32 A3 Simple fracture, transverse (<30°)

32 B=Wedge fracture

32 B1 Wedge fracture, spiral wedge

32 B2 Wedge fracture, bending wedge

32 B3 Wedge fracture, fragmented wedge

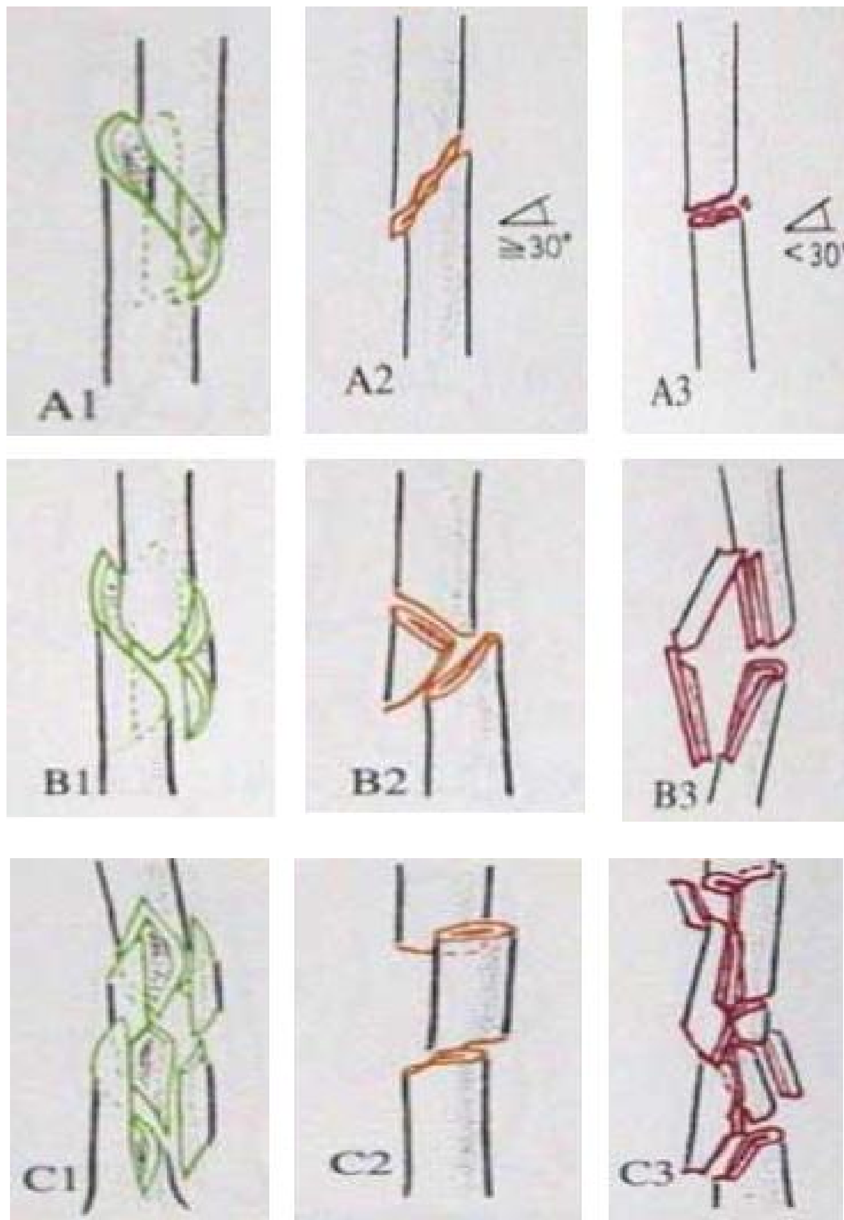
32 C=Complex fracture

32 C1 Complex fracture, spira

32 C2 Complex fracture, segmental

32 C3 Complex fracture, irregular

AO CLASSIFICATION OF DIAPHYSEAL FRACTURES OF FEMUR & TIBIA



AO system of classification of fractures of Tibia / Fibula Diaphysis

42 A=Simple fracture

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42 B=Wedge fracture

42 B1 Wedge fracture, spiral wedge

42 B2 Wedge fracture, bending wedge

42 B3 Wedge fracture, fragmented wedge

42 C=Complex fracture

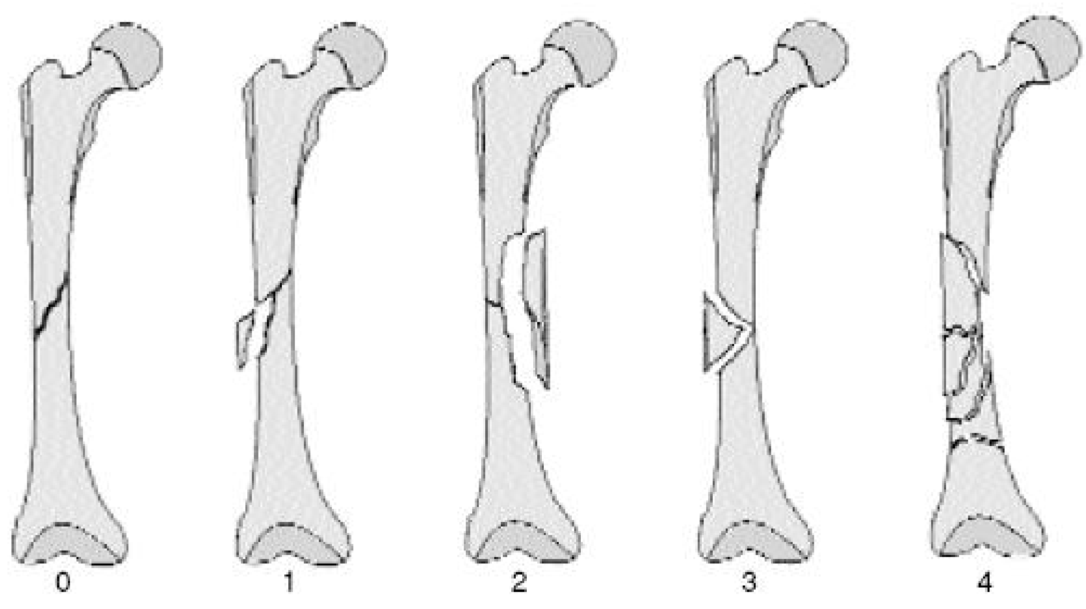
42 C1 Complex fracture, spira

42 C2 Complex fracture, segmental

42 C3 Complex fracture, irregular

Winquist and Hansen classification of fracture comminution

Grade	Degree of Comminution
0	No comminution
I	Small butterfly fragment or comminuted segment with at least 50% cortical contact remaining between the diaphyseal segments
II	Large butterfly fragment or comminuted segment with >50% cortical contact between the diaphyseal segments
III	Large butterfly fragment or comminuted segment with <50% cortical contact between the diaphyseal segments
IV	Complete cortical comminution such that there is no predicted cortical contact between the diaphyseal segments. Segmentally comminuted



TREATMENT OPTIONS

Fractures of shaft of femur

Closed and nonoperative treatment

Several methods of closed management exist for the treatment of femoral shaft fractures. These include spica casting, traction, cast bracing, or combinations thereof. Currently, conservative management as definitive treatment for femoral shaft fractures is largely limited to instances in which devices for internal fixation are unavailable or in patients with significant medical co-morbidities that make femoral stabilization impossible.

External Fixation

External fixation as a definitive treatment method for femoral shaft fractures has limited indications. However, temporary external fixation is used with increasing frequency in some valuable circumstances. Unfortunately, these devices are poorly tolerated by the patient over the extensive time necessary to ensure adequate healing of the fracture.

Indications for External Fixation

- Severe soft tissue injuries with extensive contamination.
- Evolving muscular crush that requires an extensive secondary debridement.
- Medullary contamination.
- Associated vascular injury requiring stabilization before repair.
- Polytrauma or injuries that prevent other treatments; as a temporary bridge to femoral nailing **(damage control orthopaedics)**

Plate osteosynthesis

The use of plate fixation for the routine treatment of femoral shaft fractures has decreased with the increased use of intramedullary nails. The main disadvantages associated with plate fixation when compared with intramedullary nailing are the need for an extensive surgical approach with its associated blood loss, infectious complications, and soft tissue insult. This can result in associated quadriceps scarring and its effects on knee motion and quadriceps strength. Further, the impact of the plate on the femur after fixation cannot be minimized. This includes the decreased vascularization beneath the plate and the stress shielding of the bone spanned by the plate. Minimally invasive techniques of plate application, although not addressing all of the issues associated with plating, do minimize the additional vascular insult to the periosteal and medullary blood supply of the femur. Finally, because the plate is a load-bearing implant, implant failure is expected if union does not occur.

Indications for Plating

- Patients with an extremely narrow medullary canal.
- Fractures around or adjacent to a previous malunion.
- Fractures extending proximally or distally into the pertrochanteric or metaphyseal region.
- Associated vascular injury requiring repair.
- Ipsilateral fractures of neck and shaft of femur.
- Any femur fracture.

4. Antegrade intramedullary nailing

These implants relied on the endosteal contact between the nail and the femur for control of rotation, angulation, and length. The perceived advantages compared with other techniques included early joint mobility, early weight bearing, shortened hospital stay, decreased pain, and predictable union. Fracture comminution and segmental fractures could be treated with antegrade reamed nails with reports of 100% union and no infections.

As interlocking became available, the indications for antegrade intramedullary nailing continued to expand and the results have continued to improve.

5. Retrograde Intramedullary Nailing

Retrograde femoral nailing was first introduced by Kuntscher for the treatment of pertrochanteric femoral fractures. A variety of techniques and implants were subsequently described including flexible implants introduced through extra-articular distal femoral portals with and without distal femoral locking capabilities. These implants were used to treat both distal and proximal femoral fractures, as well as to prophylactically stabilize proximal femoral metastases. An extra-articular medial condylar starting portal was suggested by Swiontkowski et al for the treatment of ipsilateral femoral neck and shaft fractures, using antegrade femoral implants. Sanders et al expanded the indications to include the multiply injured patient, other ipsilateral fractures, and pregnancy. Insertion of both femoral nails and tibial nails was possible using a medial condylar distal femoral entry site, enabling fracture healing in difficult situations.

Indications for Retrograde Nails

Relative Indications	• Multiply injured patients or polytrauma • Bilateral femur fractures • Morbid obesity • Distal metaphyseal fractures • Pregnancy • Associated vascular injury • Associated spine fracture • Ipsilateral femoral neck fracture • Ipsilateral acetabular fracture • Ipsilateral patella fracture • Ipsilateral tibia fracture • Ipsilateral through knee amputation
Relative contraindications	• Subtrochanteric fracture • Limited knee motion (if starting point inaccessible) • Patella baja • Open fractures

Fractures of tibia and fibula

1. Nonoperative treatment

Non-operative management can be undertaken using either long-leg casts, patellar tendon-bearing casts, which allow knee movement, or functional braces, which permit both knee and hindfoot movement.

Nonoperative management of tibial diaphyseal fractures is associated with an increased incidence of nonunion and malunion but the major problem associated with the technique is hindfoot stiffness, which has been shown to lead to significant disability.

The use of casts or braces should be confined to low-energy fractures occurring in young patients where the surgeon can reasonably expect to remove the cast after about 12 weeks. Younger patients immobilized for short periods develop less hindfoot stiffness. Open fractures and displaced high-energy tibial diaphyseal fractures should not be treated by a cast or brace.

2. Intramedullary nailing

Locked intramedullary nailing has revolutionized the management of tibial diaphyseal fractures. Unlocked nails have been used, but as very few tibial fractures are transverse or short oblique fractures located close to the isthmus, unlocked nailing is inappropriate for many closed and for most open fractures. Hence interlocking is nowadays routinely done in almost every case of tibial intramedullary nailing.

Reamed nailing of closed tibial diaphyseal fractures gives better clinical results than undreamed nailing. This is not true of severe open tibial fractures, where the results of reamed and undreamed nailing appear to be very similar.

Tibial reaming enhances periosteal blood flow and increases muscle perfusion. It reduces endosteal blood flow for a period but this seems to have little clinical effect. Unlike femoral reaming, it seems to have little coagulative effect and does not cause adult respiratory distress syndrome (ARDS).

3. Plate osteosynthesis

Plating is the most difficult of the four main methods of treating tibial fractures. It requires open surgery, and the location of the incision and careful handling of the soft tissues are vital in order to minimize complications. No matter how much care is taken, however, soft tissue damage and periosteal stripping is inevitable, and this is a particular problem in comminuted or open fractures.

It is therefore not surprising that the results of plating severe open fractures were uniformly poor. It would be interesting to analyze the use of plates with modern plastic surgery technique, but even if these were used, plating still results in more soft tissue damage than is associated with intramedullary nailing or external fixation, and it seems unlikely that the results would be as good.

The recent development of locking plates has potentially increased the scope of plating as treatment for proximal and distal tibial fractures. Currently, tibial plating cannot be advocated for the routine management of diaphyseal fractures. Not only does it cause unnecessary soft tissue damage, but it is also inappropriate in very comminuted fractures, as long plates are required. The only circumstances in which it might be used is when there is a proximal tibial diaphyseal fracture or when there is a combination of a proximal diaphyseal fracture and a tibial plateau fracture. Under these circumstances, the use of locking plates rather than conventional plates is preferred.

4. External fixation

External fixation is the oldest of the commonly used treatment methods for tibial diaphyseal fractures. It was widely used in the early part of the 20th century, but fell into disrepute after World War II. Its use was popularized again in the 1970s and 1980s, and many surgeons continue to use external fixation, particularly for severe open tibial fractures, in the belief that the incidence of infection is less, as there is no metal implant across the fracture site and that the technique is associated with less vascular damage in tibia that is already compromised.

External fixation is associated with a higher incidence of non-union and malunion than intramedullary nailing. To minimize these problems, accurate fracture reduction is essential and the frame should be maintained long enough to prevent a secondary fracture malposition. Alternatively, the surgeon can use primary external fixation and secondary internal fixation, usually with an intramedullary nail.

Pin tract sepsis is the commonest complication of external fixation. Its incidence can be minimized by careful surgical technique during pin insertion and by proper postoperative pin site care. Osteomyelitis rarely follows pin tract sepsis but surgeons should be particularly careful about secondary intramedullary nailing in the presence of discharging pin tracts.

MATERIALS AND METHODS

24 patients with ipsilateral fractures of shaft of femur and both bones leg / tibial shaft were included in the study. 18 were males and 6 were females. The age of the patients ranged from 19 to 55 years. The period of study was from May 2004 to December 2007.

All patients were followed up regularly at least up to the fracture union. Mean follow up period was 25 months.

INCLUSION AND EXCLUSION CRITERIA

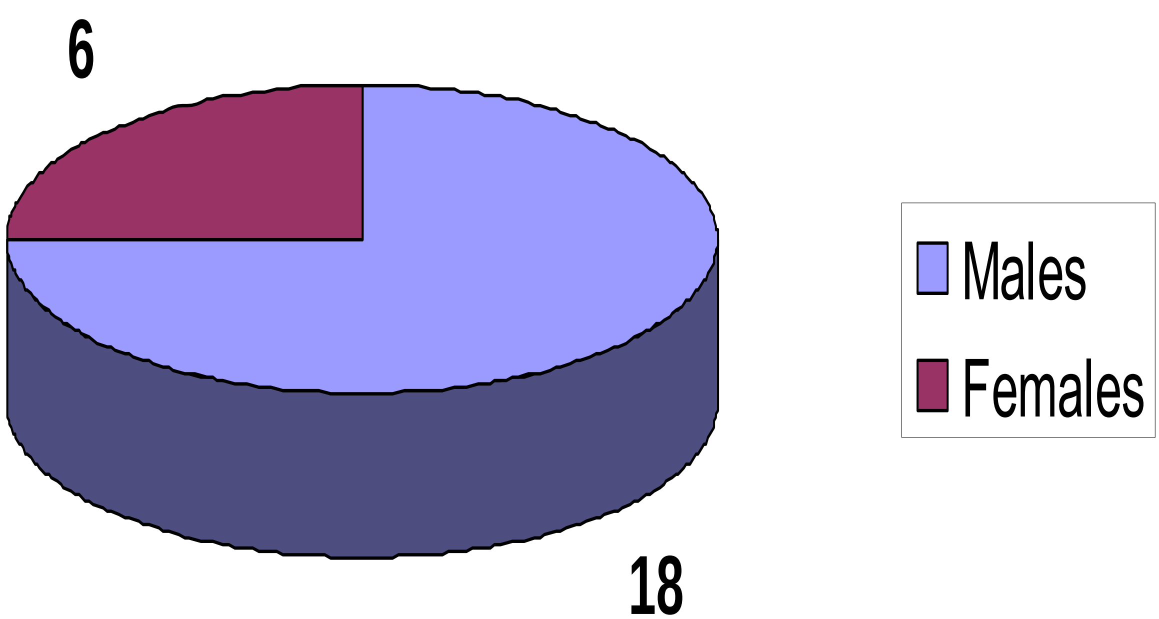
Patients with significant intraarticular extension of the fracture or with significant neurovascular deficit or with wound status precluding intramedullary nailing in compound fractures were excluded from the study.

We operated 27 patients fulfilling the above criteria. Of them only 24 were included for the final analysis. Of the excluded patients one had fat embolism preoperatively and an alternate method of fixation was undertaken, one had segmental bone loss while attempting open reduction of femur shaft fracture which was later plated, one underwent regular antegrade nailing of both fractures because the patient did not consent for retrograde femoral nailing.

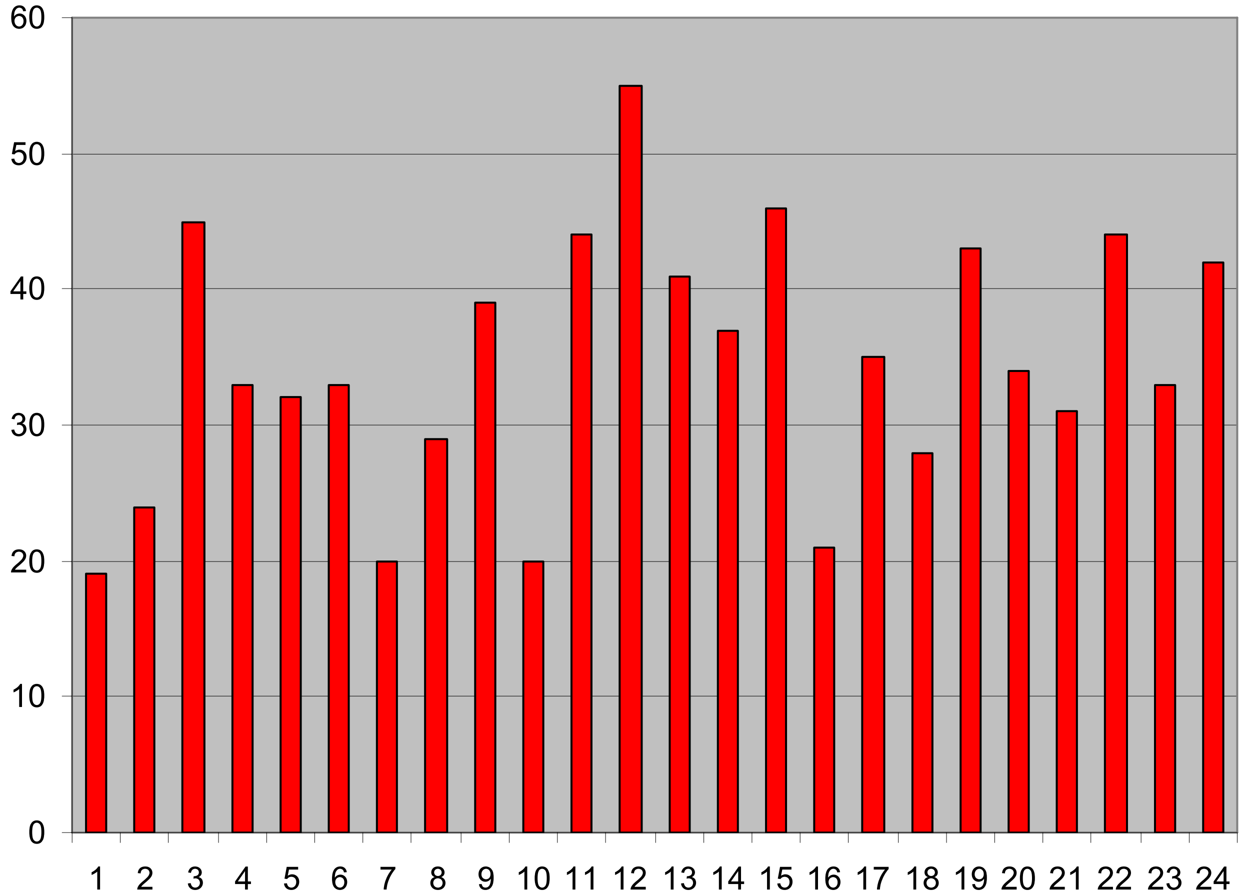
All the other patients underwent retrograde found femoral nailing and antegrade tibial nailing through a single percutaneous incision. Patients with other associated injuries requiring surgery underwent the same on the same operating table in a single sitting.

No. of patients	No. of patients	Percentage
Males	18	75%
Females	6	25%

SEX RATIO

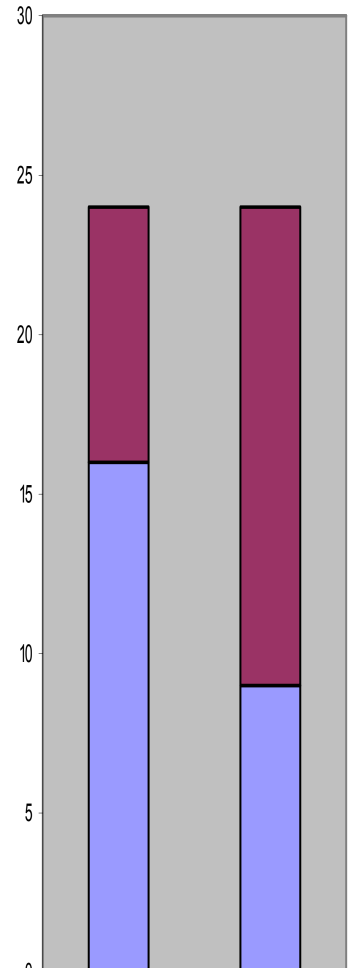


AGE



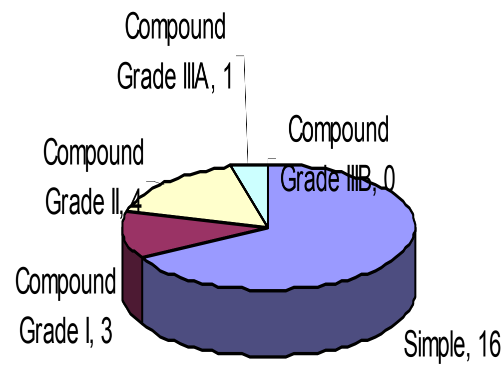
Mean Age = 34.5 years

COMPOUND FRACTURES

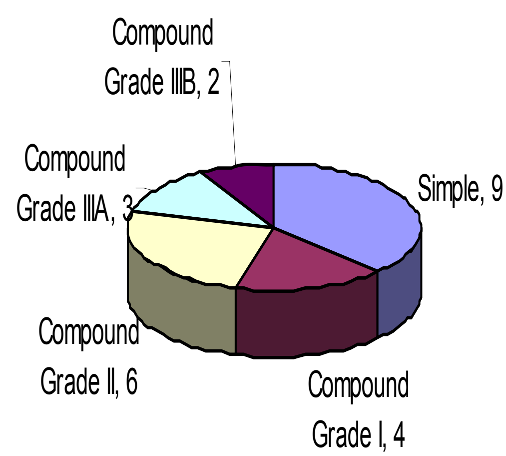


	Femur	Tibia
Compound	8	15
Simple	16	9

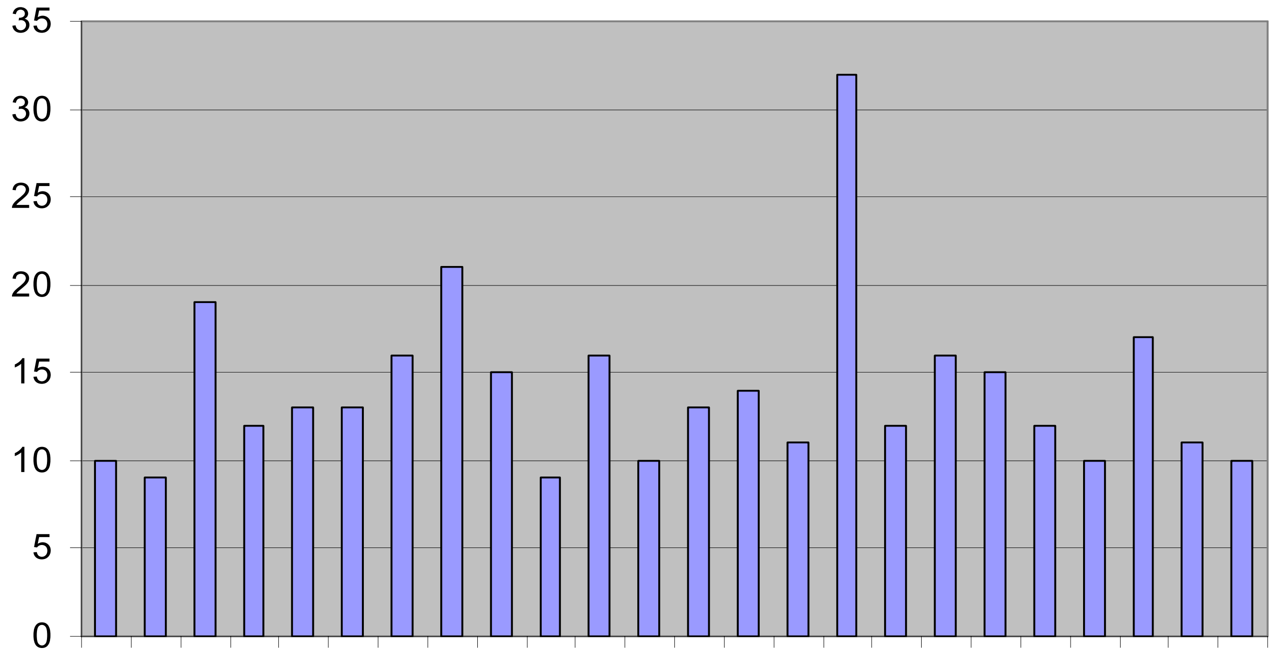
FEMUR



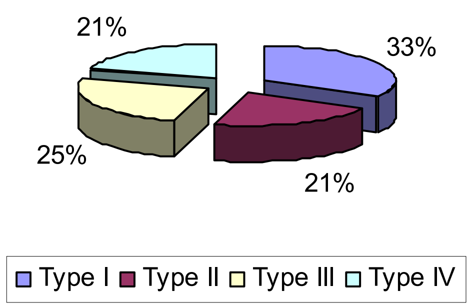
TIBIA



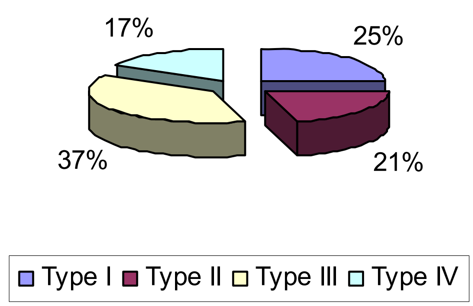
INJURY SEVERITY SCORE



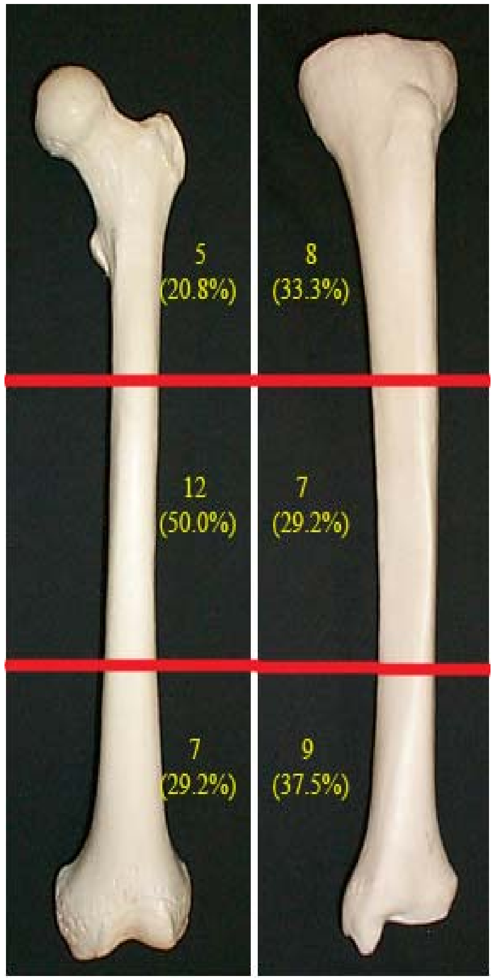
Fracture Communition - Femur



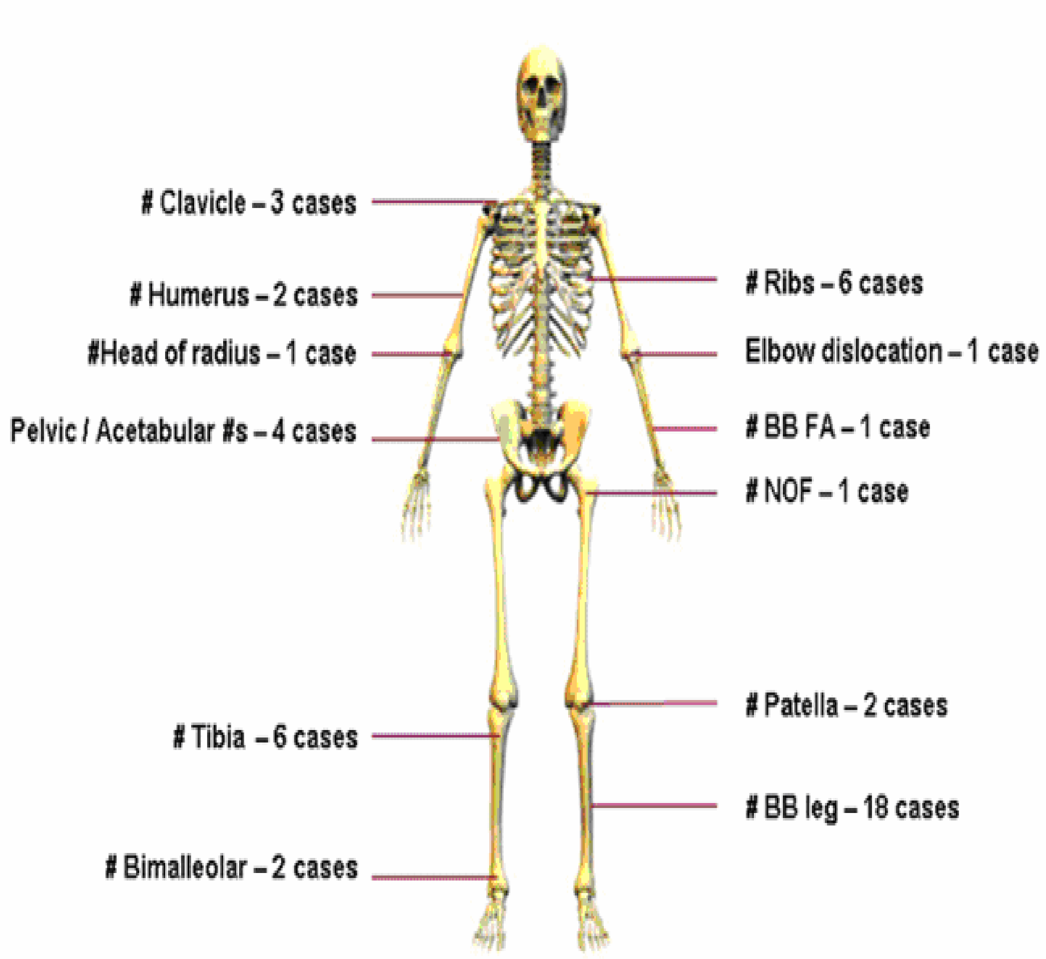
Fracture Communition - Tibia



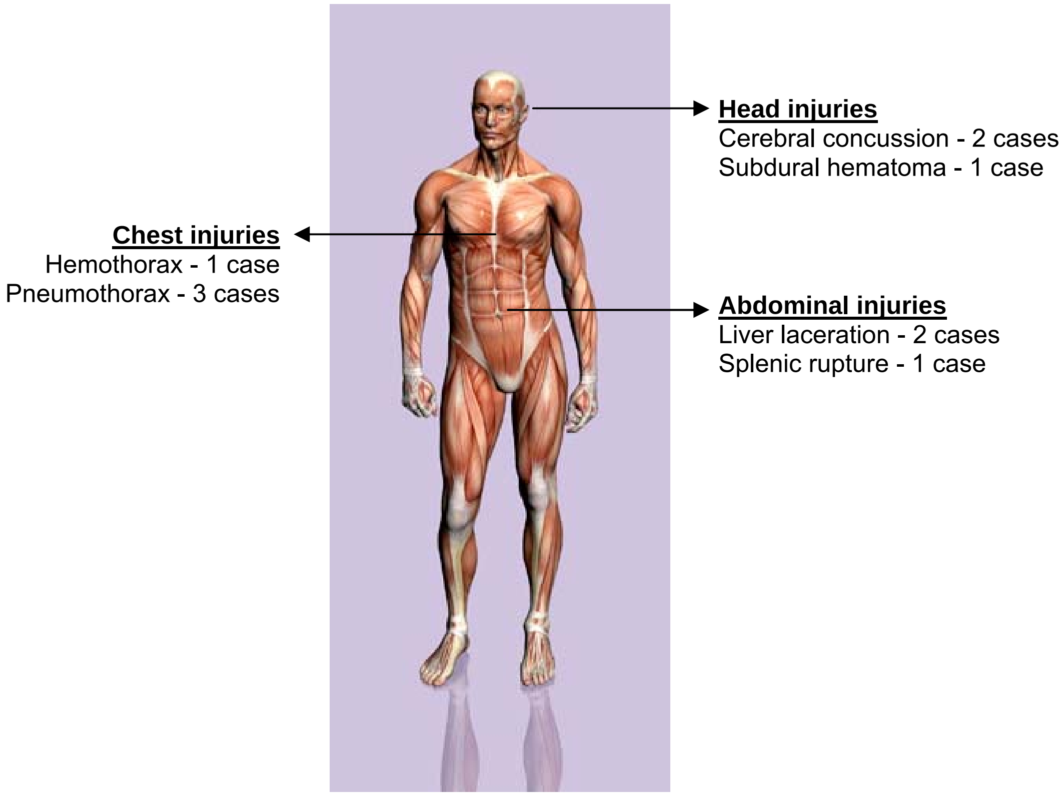
S.No.	Age	Femur			Tibia			ISS	Knee ROM
		AO	W&H	Compound Grade	AO	W&H	Compound Grade		
1	19	B1	2	Simple	A2	1	Simple	10	120
2	24	A1	1	Simple	B2	2	Simple	9	120
3	45	B1	3	Compound Grade II	B2	3	Compound Grade IIIA	19	110
4	33	B3	2	Simple	B3	3	Compound Grade I	12	110
5	32	C3	4	Compound Grade IIIA	A2	1	Simple	13	140
6	33	A2	1	Simple	B1	2	Simple	13	120
7	20	B2	2	Simple	A3	1	Simple	16	120
8	29	A3	1	Compound Grade I	B1	3	Compound Grade I	21	110
9	39	B2	3	Simple	B2	3	Compound Grade II	15	120
10	20	A1	1	Simple	B2	2	Simple	9	140
11	44	B3	3	Compound Grade I	C2	4	Compound Grade IIIB	16	90
12	55	A1	1	Simple	C1	4	Compound Grade IIIB	10	100
13	41	B2	3	Compound Grade I	B2	3	Compound Grade II	13	130
14	37	B3	2	Simple	A1	1	Simple	14	130
15	46	C3	4	Compound Grade II	A1	1	Compound Grade I	11	120
16	21	B3	3	Simple	B2	4	Simple	32	140
17	35	C2	4	Simple	A1	1	Simple	12	130
18	28	A3	1	Simple	C2	4	Compound Grade II	16	120
19	43	C2	4	Compound Grade II	B1	2	Compound Grade IIIA	15	110
20	34	B2	3	Simple	B1	3	Compound Grade I	12	120
21	31	A1	1	Simple	B2	3	Compound Grade II	10	120
22	44	C1	4	Compound Grade II	B1	3	Compound Grade II	17	130
23	33	B2	2	Simple	B2	2	Compound Grade II	11	120
24	42	A2	1	Simple	B2	3	Compound Grade IIIA	10	110



Location of #		
Proximal 1/3	5	8
Middle 1/3	12	7
Distal 1/3	7	9



ASSOCIATED FRACTURES	
# Ribs	6 cases
# Clavicle	3 cases
# Humerus	2 cases
Elbow dislocation	1 case
#Head of radius	1 case
# BB FA	1 case
Pelvic / Acetabular #s	4 cases
# NOF	1 case
# Patella	2 cases
# Bimalleolar	2 cases
# BB leg	18 cases
# Tibia	6 cases



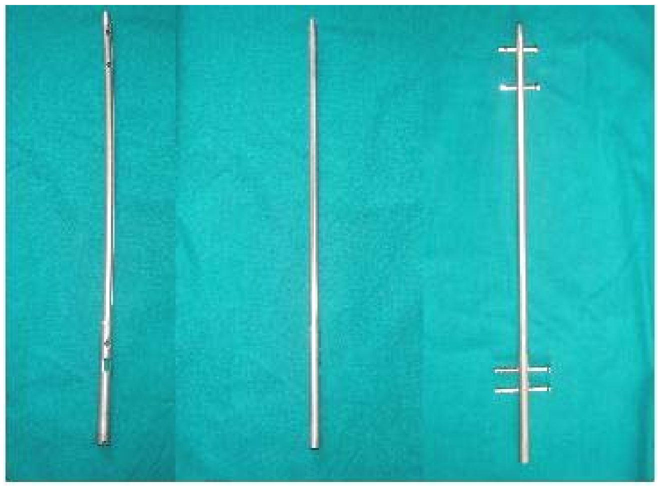
Head injuries
Cerebral concussion - 2 cases
Subdural hematoma - 1 case

Abdominal injuries
Liver laceration - 2 cases
Splenic rupture - 1 case

Chest injuries
Hemothorax - 1 case
Pneumothorax - 3 cases

INSTRUMENTATION

We used reamed and statically locked retrograde femoral nails in all the patients in our series.



For all our tibial fractures, we used reamed and statically locked antegrade tibial nails. In patients with high grade compound fractures, we employed an unreamed technique using a small size nail, usually 8 mm.

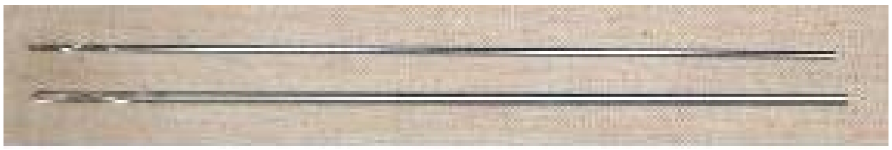
The instrumentation comprises of:

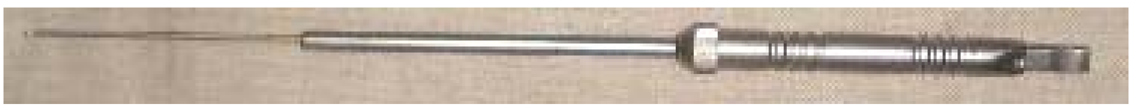
Curve Bone Awl

Proximal and Distal Targeting Jig

Conical Bolt and Ramming Head


Trocar and Drill Sleeves


Drill Bits (3.5mm and 4 mm)


Depth Gauge


4.5mm Screw Driver (Long)


Guide wire exchange tube


Wrench Spanner

Tissue Protector

Guide wires

Extraction Assembly

When using reamed nails, reaming was either done with rigid reamers or flexible reamers on the preference of the surgeon.

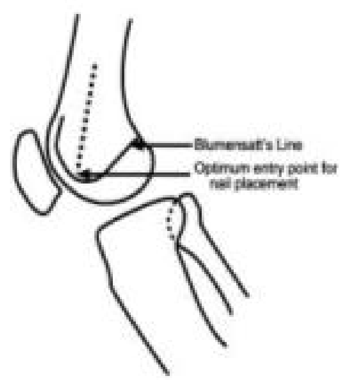
SURGICAL TECHNIQUE

The patient is positioned supine on a radiolucent table that allows unimpeded fluoroscopy from the knee to the hip. A small bump beneath the ipsilateral flank may help avoid external rotation of the leg. The entire leg and hip are prepped to the iliac crest and medially to allow access to the femoral artery if needed. Pharmacologic relaxation is necessary in all cases, especially if manual traction is the primary reductive force. The c-arm is positioned perpendicular to the long axis of the table on the contralateral side to allow for ease with imaging and placement of interlocking screws.

Knee flexion of 30 to 60 degrees is necessary to allow identification of the proper entry portal and placement of the nail. This can easily be accomplished with several bolsters or a large radiolucent triangle. Femoral length and fracture reduction can be accomplished manually, with a femoral distractor or with percutaneous and unicortical Schanz pins used as joysticks. As with any nailing procedure, the fractures should be reduced during reaming and nail placement, and until interlocking is complete.

A longitudinal incision centered between the inferior pole of the patella and the tibial tubercle is optimal. A smaller incision of 2 to 3 cm at the location of the perfect starting portal is certainly possible and preferred by many surgeons. The approach can be accomplished medial to or through the central portion of the infrapatellar tendon.

The starting point can be palpated or identified radiographically. The location for the proper starting point is anterior to the posterior cruciate ligament origin and at or slightly medial to the intercondylar sulcus in line with the canal of the femur. This has been identified as 6.2 to 12mm anterior to the posterior cruciate ligament femoral attachment and through the articular cartilage of the posterior intercondylar sulcus. Alternatively, the entry site can be identified radiographically on the basis of the lateral fluoroscopic image. With the femur rotate into a perfect condylar overlap lateral view, the proper entry site is at the apex of Blumensaat's line.



Given the anatomic valgus of the distal femur the entry angle should not be perpendicular to the femoral articulation because this can produce a varus reduction if the fracture is located distal to the femoral isthmus. Instead, the entry angle should be in 5 to 9 degrees of valgus as confirmed on the intraoperative AP fluoroscopic image, coincident with axis of the femoral canal. The starting point can be initiated with either a sharp awl or a cannulated drill. Use of a cannulated drill has the advantage of allowing for minor corrections in the entry angle before committing with a large opening in the distal femoral articular surface.

For placement of a reamed nail, a ball-tipped guidewire is placed across the fracture and into the medullary canal of the opposite segment. The guidewire should be advanced proximal to the lesser trochanter to ensure placement of a long implant. Reaming is performed with the fracture reduced and the knee flexed to the proper degree that minimizes damage to the inferior pole of the patella, the proximal tibia, and the distal femoral articulation. The canal should be over-reamed by at least 1 mm greater than the desired nail diameter. If a proximal femoral or ipsilateral acetabular fracture is present, consideration should be given to over-reaming by 1.5 to 2.0mm to allow for atraumatic nail passage.

Distal interlocking is typically facilitated with a targeting jig that allows placement of a variable number of screws from lateral to medial. The knee joint should be vigorously irrigated after nail placement to remove any debris that has accumulated from reaming. Proximal interlocking can be performed from anterior to posterior or from lateral to medial depending on the design of the nail.

The knee is then hyperflexed to allow access to the proximal tibia. The starting point can be made using a bone awl. After reaming as required, intramedullary tibial nail is inserted and proximal and distal cross locking done in a medial to lateral fashion. Alternatively for open fractures a small diameter (8mm) nail can be inserted without reaming after debridement of the wound.

After thorough wound irrigation, an active function drain may be placed in the knee wound closed in layer after perfect hemostasis. Sterile bulky dressing applied.

AFTER TREATMENT

Operative stabilization of femoral shaft fractures allows early patient mobilization, decreases pain, facilitates nursing care, minimizes joint stiffness, and allows early functional rehabilitation. Early mobilization avoids many of the complications associated with prolonged recumbency such as pulmonary compromise, pressure sores, and muscle deconditioning.

Patients should be encouraged to sit up and get out of bed immediately after fixation. Because of the strength of a femur treated with a statically locked intramedullary nail, there should be virtually no concern by the patient or the physician regarding the stability of the mechanical construct. This applies to femurs stabilized with both antegrade and retrograde nailing techniques. Quadriceps and hamstrings exercise can proceed according to the patient's comfort. Unrestricted active and passive range-of-motion exercises of the knee and hip can similarly be instituted immediately after surgery. Restoration of motor strength is dependent on the traumatic injury to the muscles, any associated injuries, and the patient's motivation.

Weight bearing on the extremity is guided by a number of factors including the patient's associated injuries, the soft tissue injury, and the location of the fracture. For fractures treated with the currently manufactured intramedullary nails, immediate weight bearing is safe from a mechanical standpoint. Brumback et al reported the biomechanical and clinical results of stimulated and actual early weight bearing using commonly available implants. They found that immediate weight bearing of segmentally comminuted mid-isthmal fractures treated with a statically locked intramedullary nail using two distal interlocing screws was safe and allowed healing without shortening or nail fatigue failure. Similarly, Arazi et al followed 24 patients with comminuted diaphyseal femur fractures for a minimum of 1 year. Unrestricted weight bearing was allowed, and most patients were able to bear weight between 2 and 4 weeks after surgery. No nail-related mechanical failures occurred, and all fractures healed without complications. An interlocking screw in each of two patients demonstrated some bending, but this was without consequence. The experience reported in these two studies supports the contention that early weight bearing after reamed statically locked intramedullary nailing is safe. Early weight bearing may encourage callus formation and should be encouraged in applicable fracture patterns. Fractures with proximal or distal extension and associated ipsilateral femoral fractures required individual modification to the weight-bearing progression. If weight bearing is limited during the first 6 to 12 weeks, an ankle dorsiflexion splint or orthosis should be used to avoid an equinus contracture.

CONTINUOUS PASSIVE MOTION (CPM)

SLIDING CHAIR EXERCISES FOR KNEE FLEXION

BICYCLING EXERCISES FOR INCREASING KNEE FLEXION

WALKING TRAINING BETWEEN PARALLEL BARS

Radiographic evaluations are usually obtained 6 weeks, 12 weeks, and 6 months and should include two views of the entire femur and leg to include the proximal and distal interlocking screws as well as the hip, knee and ankle joints.

DATA ANALYSIS

The following data was collected for all the patients

• Age • Gender • Side of fracture • Mechanism of injury • Comminution • Compound grade • Injury Severity Score	• Operating time • C-arm exposure time • Blood loss • Time to union • Hospital stay • Secondary procedures • Complications

The operating time was calculated from the start of the surgical incision to wound closure. It was found be on an average of 112 min ± 17 min. The blood loss was calculated according to the number of surgical pads soaked and was found to be on the average of 143 ml ± 44 ml. The mean duration of image intensifier usage was found to be 51 sec ± 19 seconds. All cases were followed at least up to fracture union. The various definitions used for union were

- Clinical union - the ability to perform a single leg stance on the injured limb without pain or instability
- Radiographic union - three bridging cortices seen on the combined antero-posterior (AP) and lateral radiographs.

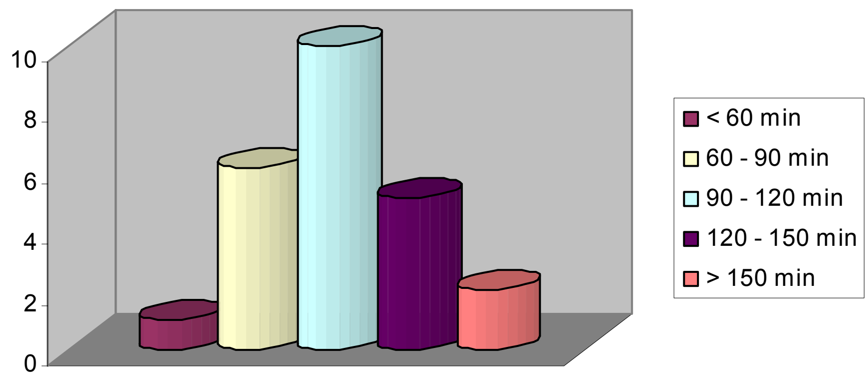
Union was considered to be delayed if the fracture line is still visible or if there is failure of progression at 24 weeks. All fractures went in for uneventful union. The mean time to union was 19.6±7.1 weeks for femoral shaft fractures and 21±6.9 weeks for tibial shaft fractures.

The latest follow up examination revealed that the average knee range of motion was 0° to 120° (90° to 130°).

• Operating time	112 min ± 17 min
• C-arm exposure time	51 sec ± 19 sec
• Estimated blood loss	143 ml ± 44 ml
• Time to union	19.6±7.1 weeks (femoral shaft fractures) 21±6.9 weeks (tibial shaft fractures)
• Hospital stay	14 days (8 to 54 days)
• Mean time to surgery	8 days (range 4 to 42 days)
• Mean follow-up period	All the patients were followed at least up to fracture union. Mean = 25 months

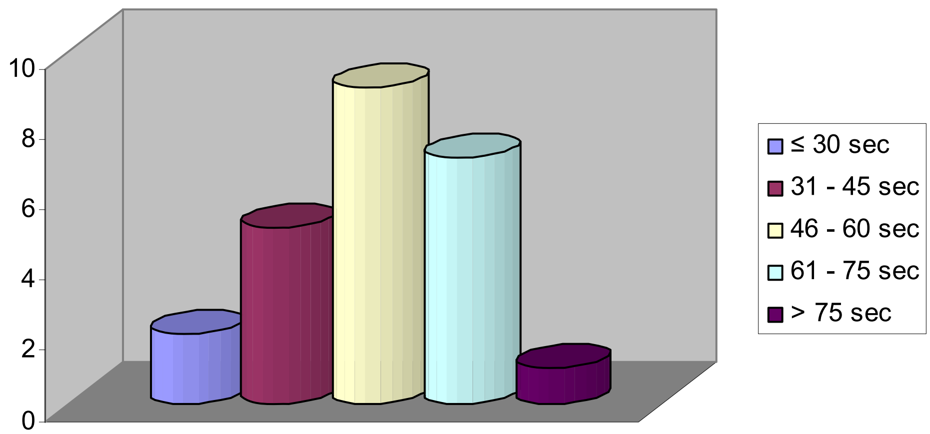
We experienced 3 cases of superficial wound infection which was managed with I.V antibiotics and debridement. There was a single case of deep wound infection which necessitated metal exit and the end of fracture union.

OPERATING TIME

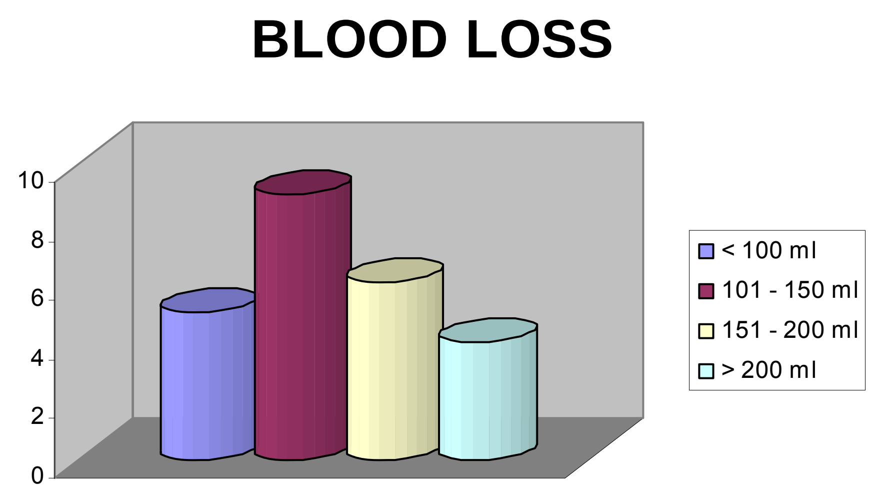


Operating Time	
< 60 min	1
60 - 90 min	6
90 - 120 min	10
120 - 150 min	5
> 150 min	2

C-ARM EXPOSURE TIME

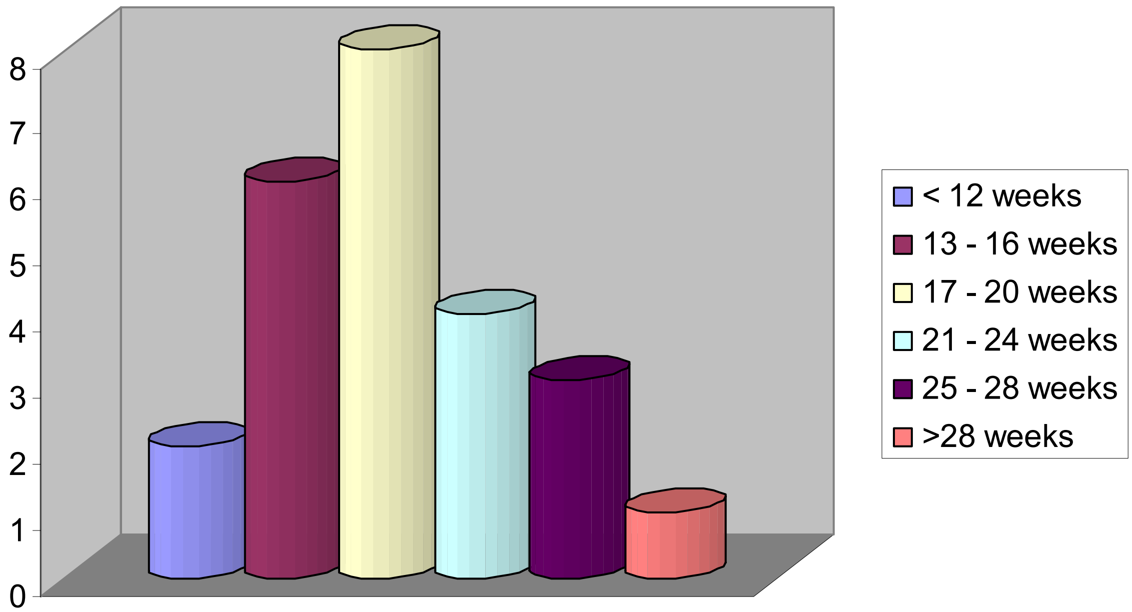


C-Arm Exposure Time	
≤ 30 sec	2
31 - 45 sec	5
46 - 60 sec	9
61 - 75 sec	7
> 75 sec	1



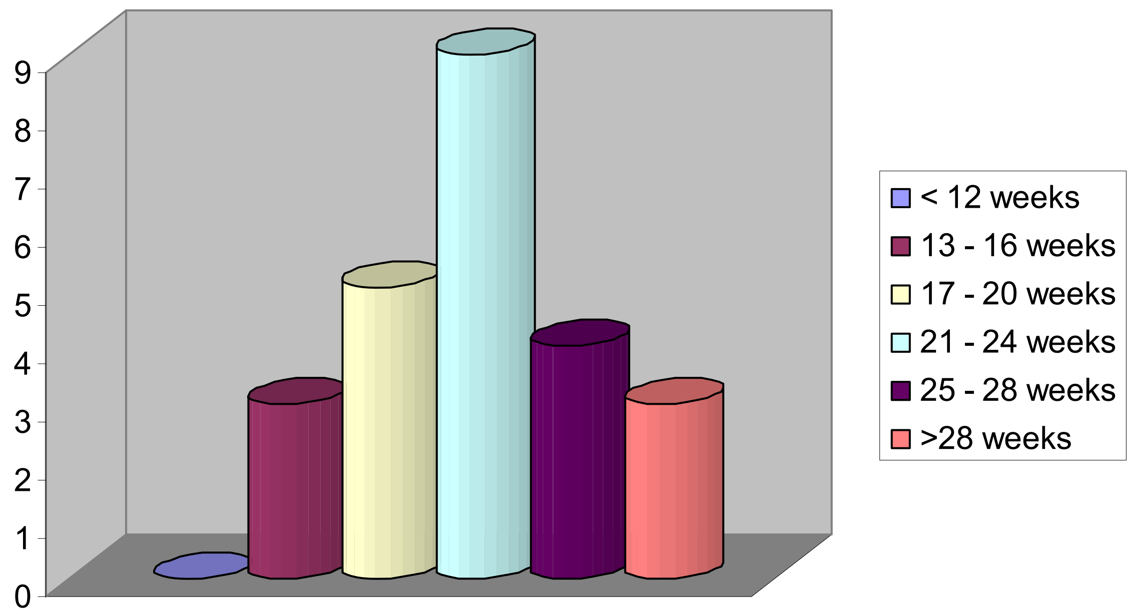
Blood Loss	
< 100 ml	5
101 - 150 ml	9
151 - 200 ml	6
> 200 ml	4

TIME TO UNION - Shaft of Femur



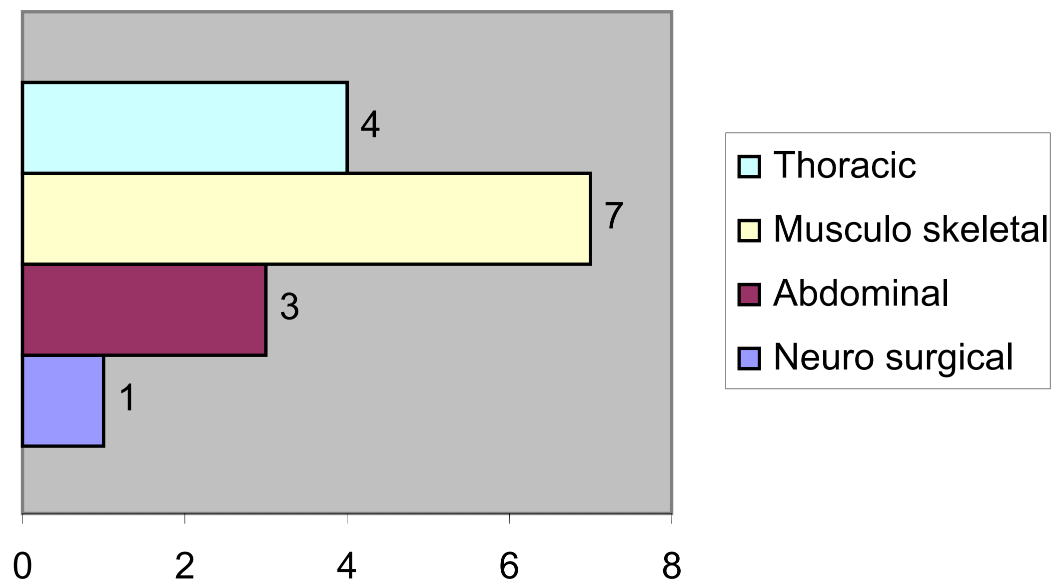
TIME TO UNION - Shaft of Femur	
< 12 weeks	2
13 - 16 weeks	6
17 - 20 weeks	8
21 - 24 weeks	4
25 - 28 weeks	3
>28 weeks	1

TIME TO UNION - Tibia



TIME TO UNION - Tibia	
< 12 weeks	0
13 - 16 weeks	3
17 - 20 weeks	5
21 - 24 weeks	9
25 - 28 weeks	4
>28 weeks	3

ASSOCIATED SURGERIES PERFORMED



ASSOCIATED SURGERIES PERFORMED	
Neuro surgical	1
Abdominal	3
Musculo skeletal	7
Thoracic	4

Retrograde femoral nailing was found to be particularly suited to the management of ipsilateral fractures of the femur and tibia. The patient can be managed on a standard radiolucent operating table with no need for repositioning between fixations of the two fractures. A single percutaneous medial para patellar incision allows ready access to the starting points for both the tibial and femoral nail entry points. Since the surgery is performed in an ordinary radiolucent table in supine position other surgical teams can operate simultaneously on head, truncal, or other extremity injuries, if necessary.

The theoretical possibility of iatrogenic injury that may occur during establishment of an intra articular starting point in the inter condylar notch was found to be of great concern & apprehension among most surgeons. Of significance, no patient in our series complained at the time of review of any significant pain at the knee, and long-term range of motion was excellent. Although retrograde techniques for intramedullary nailing of femur fractures are new and unfamiliar to many surgeons, we feel that these results demonstrate this to be a promising technique with minimal knee morbidity.

AVERAGE SIZE OF THE INCISION

POSTOPERATIVE SCAR

REVIEW OF LITERATURE

Long-term results were comparable with those reported using other treatment modalities. 70% of our patients had good or excellent functional outcome according to the criteria of Karlstrom and Olerud. The remainder had an acceptable outcome.

Veith et al. found a similar 74% incidence of good and excellent results in their 26 patients treated with operative stabilization of both fractures. Their technique was variable using antegrade femoral nailing for all femoral fractures and fixation of the tibial fractures with a variety of devices

Anastopoulos et al. noted an incidence of 81% good and excellent results in their group of 32 patients treated with antegrade femoral nailing and external fixation of the tibia

The short-term and systemic benefits of our nailing techniques, which arise mainly from early stabilization of the fractures, are comparable with those of other reported methods of stabilization. The average hospital stay of 14 days (range 8 to 54) in this series compared favorably with that reported in other series in which both fractures were stabilized.

We had no recognized case of adult respiratory distress syndrome, fat embolism, or deep venous thrombosis, which most likely reflects early stabilization of the fractures and early mobilization of the patients. We encountered one case of bilateral floating knee with fulminant ARDS that manifested within 6 hours of injury. The patient succumbed ultimately even before being operated, despite timely ventilatory support.

The operative time in our series was also far less when compared to the conventional antegrade techniques. This was partly because there was no need for repositioning between fixations of the two fractures. Moreover we also feel that technically the procedure was far easily done when compared to the conventional antegrade techniques except for an occasional difficulty we faced in proximal free hand locking.

The outcome and complications of the individual fractures were comparable with other reported series. The end results for femoral alignment, infection, and healing mirrored those found in recent series of floating knees using the traditional antegrade femoral nailing technique.

The tibial fractures, although more problematic than the femoral injuries, did not result in an unexpectedly high complication rate considering the severity of the injuries encountered.

CONCLUSION

In conclusion, based on this group of patients, treatment of the floating knee lesion with the technique of retrograde nailing of the femoral fracture and ante grade nailing of the tibial fracture yields results at least as good as other methods of stabilization. In addition, it offers the practical advantages of a simple and efficient technique for these often multiply injured patients. Neither significant irritation nor interference with knee function was encountered. However, this study did have several shortcomings. The length of follow-up was short for some patients, and no specific functional outcome assessment tool was used. These problems notwithstanding, the results of this technique seem good enough to justify further evaluation with a well-designed, prospective, randomized evaluation with standardized functional outcome assessment.

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PROFORMA

Serial No. | I.P. No:

Serial No.	I.P. No:
Name :	DOA:
Age :	DOS:
Sex:	DOD :
Address :	
	Hospital :
Occupation	Unit:

Informant :

HISTORY

Presenting Complaints :

- **Pain**
- **Swelling**
- **Restriction of movements**
- **Deformity**

History of Presenting Illness

- Mode of injury
- Place of injury - Domestic / road traffic accident / farm yard / assault / others

Associated injuries if any:

Past History

Family History

Personal History

EXAMINATION

General Examination

- Vitals

  Pulse BP:

  RR: Temperature :

- Pallor
- Class of Shock. If any

Systemic Examination

CVS

RS

P/A

CNS

List of Injuries

Neurovascular status Examination

INVESTIGATIONS

Routine:

- Blood

  Hb%: TC: DC:

  ESR:

- Urine

  Albumin Sugar

  Microscopy

- RBS
- Blood Urea
- Serum Creatinine
- HIV
- HBsAg

X-ray

- Plain X-ray of full length of femur including hip and knee joint
  - AP

    - Lateral View
- Plain X-ray of full length of leg including knee and ankle joint
    - AP
    - Lateral View
- Other x-rays
- Further Imaging

Special Investigations

Diagnosis :

Management

- Pre op Immobilization

Surgical Management

- DOS – date of Surgery
- Duration between trauma and surgery
- Pre operative antibiotics
- Anaesthesia – general or spinal
- Procedure
- Duration of surgery

OPERATIVE FINDINGS

Size of nail used:

Difficulties during operation

- Difficulty to gain entry point
- Difficulty to active reduction
- Difficulty in interlocking
- Others

Management of other fractures and injuries

Post operative management

- Antibiotics
- Post operative X-ray
- Post operative immobilization
- Wound care
- Quadriceps exercise
- Knee bending exercise
- Walking training
- Date of suture removal

Advice at the time of discharge

- Quadriceps exercise
- Active movements of the hip and knee
- Walking ability

Follow up

Complications	6 weeks	12 weeks	24 weeks	1 year
Pain / deformity/swelling/ difficulty in walking / discharging wound others				
On Examination Tenderness Shortening / Lengthening Knee Movement Muscular atrophy Rotational alignment of the lower limb				
X-ray Callus formation / union Malalignment				
Restriction of knee flexion Infection Delayed union / non union				
Advice Quadriceps exercise Weight bearing				
Others				

S.No.	Age	Femur			Tibia			ISS	Knee ROM
		AO	W&H	Compound Grade	AO	W&H	Compound Grade		
1	19	B1	2	Simple	A2	1	Simple	10	120
2	24	A1	1	Simple	B2	2	Simple	9	120
3	45	B1	3	Compound Grade II	B2	3	Compound Grade IIIA	19	110
4	33	B3	2	Simple	B3	3	Compound Grade I	12	110
5	32	C3	4	Compound Grade IIIA	A2	1	Simple	13	140
6	33	A2	1	Simple	B1	2	Simple	13	120
7	20	B2	2	Simple	A3	1	Simple	16	120
8	29	A3	1	Compound Grade I	B1	3	Compound Grade I	21	110
9	39	B2	3	Simple	B2	3	Compound Grade II	15	120
10	20	A1	1	Simple	B2	2	Simple	9	140
11	44	B3	3	Compound Grade I	C2	4	Compound Grade IIIB	16	90
12	55	A1	1	Simple	C1	4	Compound Grade IIIB	10	100
13	41	B2	3	Compound Grade I	B2	3	Compound Grade II	13	130
14	37	B3	2	Simple	A1	1	Simple	14	130
15	46	C3	4	Compound Grade II	A1	1	Compound Grade I	11	120
16	21	B3	3	Simple	B2	4	Simple	32	140
17	35	C2	4	Simple	A1	1	Simple	12	130
18	28	A3	1	Simple	C2	4	Compound Grade II	16	120
19	43	C2	4	Compound Grade II	B1	2	Compound Grade IIIA	15	110
20	34	B2	3	Simple	B1	3	Compound Grade I	12	120
21	31	A1	1	Simple	B2	3	Compound Grade II	10	120
22	44	C1	4	Compound Grade II	B1	3	Compound Grade II	17	130
23	33	B2	2	Simple	B2	2	Compound Grade II	11	120
24	42	A2	1	Simple	B2	3	Compound Grade IIIA	10	110

44 YEARS OLD WITH COMPOUND GRADE – 1 # SHAFT OF FEMUR AND COMPOUND GRADE – 3B # BOTH BONES LEG

PRE OP

POST OP

- **After wound debridement and skeletal stabilization with reamed retro grade femoral nail and unreamed ante grade tibial nail, the residual raw area was given flap cover with gastroenemius muscle flap and split skin grafting, in the same sitting (Fix and Flap Technique).**

28 YEARS OLD MALE WITH SIMPLE # SHAFT OF FEMUR AND COMPOUND GRADE – 2 # BOTH BONES LEG

AT THE END OF 20 WEEKS FOLLOW UP

29 YEARS OLD WITH COMPOUND GRADE – 1 # SHAFT OF FEMUR AND COMPOUND GRADE – 1 # BOTH BONES LEG WITH SPLIT # LATERAL CONDYLE OF TIBIA LEFT SIDE AND POSTEROLATERAL DISLOCATION ELBOW LEFT SIDE

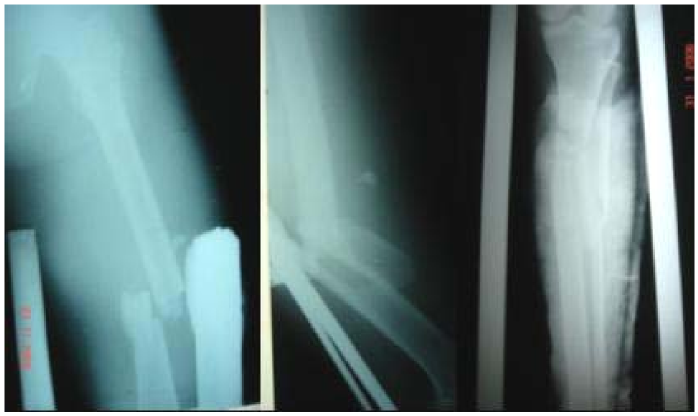
PRE OP

POST OP

- Elbow dislocation treated conservatively after closed reduction.
- # Lateral condyle closed reduction and percutaneous screw fixation done.

46 YEARS OLD WITH COMPOUND GRADE – 2 # SHAFT OF FEMUR AND COMPOUND GRADE – 1 # BOTH BONES LEG

PRE OP



POST OP

AT THE END OF 18 WEEKS FOLLOW UP

44 YEARS OLD WITH COMPOUND GRADE – 2 # SHAFT OF FEMUR AND COMPOUND GRADE – 2 # BOTH BONES LEG

PRE OP

POST OP

32 YEARS OLD WITH COMPOUND GRADE – 3A # SHAFT OF FEMUR AND SIMPLE # TIBIA WITH # RADIAL HEAD RIGHT SIDE - UNDISPLACED

PRE OP

POST OP

- # Radial head treated conservatively by rest in AE slab and elbow mobilization after 3 weeks.

20 YEARS OLD WITH SIMPLE # SHAFT OF FEMUR AND SIMPLE # BOTH BONES LEG WITH IPSILATERAL # NECK OF FEMUR –UNDISPLACED

PRE OP

POST OP

- # Neck of femur treated by closed reduction and percutaneous cannulated AO cancellous screw fixation.

34 YEARS OLD WITH SIMPLE # SHAFT OF FEMUR AND COMPOUND GRADE – 1 # BOTH BONES LEG WITH IPSILATERAL BIMALLEOLAR # (PRONATION – LATERAL ROTATION VIOLENCE)

PRE OP

POST OP

- Open reduction and internal fixation with malleolar screws and plate osteosynthesis was done for bi-malleolar fracture.

39 YEARS OLD WITH SIMPLE # SHAFT OF FEMUR AND COMPOUND GRADE – 2 # BOTH BONES LEG WITH IPSILATERAL SMITH'S # DISTAL RADIUS

PRE OP

POST OP

- Smith's # was treated conservatively by closed reduction and AE slab immobilization for 6 weeks.

33 YEARS OLD WITH SIMPLE # SHAFT OF FEMUR AND COMPOUND GRADE – 1 # BOTH BONES LEG

IMMEDIATE POST OP

AT THE END OF 42 WEEKS OF FOLLOW UP